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Linear guide unit**Field of the invention**

The present invention concerns linear guide units as used, for example, in the field of machine tools.

Background of the invention

A generic-type linear guide unit relevant to this invention is known, for example, from DE 90 11 444 U. A raceway plate or support rail arranged between the carrier body and the guide rail has a substantially triangular cross-section. The carriage comprises a groove that, as viewed in cross-section, has an approximately triangular shape, in which the raceway plate is arranged. Mutually contacting surfaces of the raceway plate and the carriage are configured so that the raceway plate is supported for swinging about an axis parallel to the direction of the rail. Further, this raceway plate comprises two ball grooves forming raceways, each of which defines a load-bearing channel for the rolling elements. The ability to swing permits compensating movements and thus enables a balancing of moments of the carriage relative to the guide rail. However, the danger exists in this solution that, due to its swinging motion, the raceway plate disengages material out of the carriage. While the raceway plates are often made of hardened material, the carriages remain unhardened, that is to say, markedly softer.

Objects of the invention

It is an object of the invention to provide a linear guide unit of the generic type in which the aforesaid drawbacks are eliminated.

This and other objects and advantages of the invention will become obvious from the following detailed description.

Summary of the invention

The invention achieves the above objects by the fact that the support rail comprises a support member and a saddle member, the support member is received on the carrier body, the saddle member comprises the raceway and is supported through a saddle surface for tilting motion on the support member.

Whereas in the known linear guide unit, tilting movements occur between the support rail and the carrier body, in the invention, the support rail in itself can tilt due to the two-piece construction. The support member being a small part can be hardened without any problem and inserted into the carrier body. The connection between the support member and the carrier body can be such that no relative movements are possible between the support member and the carrier body. Undesired wear, i.e. a rubbing-out of material out of the carrier body is thus precluded. The materials of the support member and the saddle member can be matched to each other without any problem so that undesired abrasion is minimized.

If the support member is configured, for instance, in a particularly simple manner in the form of a wire with a circular cross-section, it is sufficient for the carrier body to comprise a semi-circular groove or a groove with a gothic cross-sectional profile in which the wire is received. If, now, the saddle member executes compensating movements and, thus, tilting movements on the wire, it must be assured that a relative movement is possible between the wire and the saddle member but not between the wire and the carrier body. This can be assured in a favorable manner by the fact that a first coefficient of friction is chosen between the carrier body and the support member, and a second coefficient of friction is chosen between the support member and the saddle member, the first coefficient of friction being set to be larger than the second coefficient of friction. The setting of the coefficients of

friction can be achieved through suitable materials, surface treatments and pressing force between the carrier body and the support member.

Preferably, the support member is inserted into a groove of the carrier body and comprises a curved support surface that cooperates with the saddle surface. The curvature is configured such that the saddle surface can slide along this curved support surface.

The support member or the saddle member, or even both these components, can be made of a steel hardened by a heat treatment. The carrier body can remain soft, so that the linear guide unit of the pre-cited type can be economically manufactured.

From the economic point of view, it can be particularly interesting if the carrier body is manufactured by continuous casting and finished by vibratory grinding. Vibratory grinding is an extremely cheap method to break edges and even to further augment the hardness of the surfaces. The carrier body can be made with a high sinking speed of the tool that further increases the economy of manufacture. Moreover, in the continuous casting method, grooves and undercuts can be allowed for in a particularly simple manner. Undercuts can be advantageous, for example, if a support member configured, for instance, as a wire is pressed into an undercut groove. After the insertion of the wire, the groove wall then encloses more than half the circumference of the wire, so that this is perfectly retained, secured against loss, on the carrier body.

With a view to load distribution, the following shape has proved to be particularly advantageous: a groove to be provided in the carrier body for receiving the support member has a gothic profile as viewed in cross-section. When the wire with a circular cross-section has been inserted into this groove, a perfect alignment takes place through defined line contacts with the carrier body. Further, the saddle surface of the saddle member is preferably likewise provided with a

gothic profile, so that the contact of the wire with the saddle member is likewise clearly defined.

Basically, it is obviously advantageous if the carrier body comprises a groove that is open toward the guide rail and the groove cross-section is circular or gothic in shape and surrounds more than half the circular periphery.

Preferably, the saddle member comprises two parallel raceway of respective rolling element channels. This arrangement is particularly favorable in linear guide units comprising four rows of rolling elements. In addition to bearing forces acting crosswise to the guide rail, such linear guide units can also transmit moments without any problem.

Such saddle members comprising two parallel raceways preferably comprise one side on which the saddle surface is configured, a saddle axis of the saddle member being arranged between raceway axes of the two raceways. With this symmetric arrangement, forces can be transmitted in a favorable manner between the carrier body and the guide rail, and the tilting arrangement of the saddle member permits compensating movements.

The saddle member preferably has a generally triangular cross-section, each of a first and a second side of a total of three sides of the saddle member comprising one of the raceways for the rolling elements, while the third side of the saddle member comprises the saddle surface.

In this case, it is advantageous to configure the first and the second side with a concave raceway, in particular for rolling elements in the form of balls. This concave raceway can be configured, for instance, as a ball groove. The third surface can likewise be configured as a concave saddle surface that cooperates with the cylindrical outer peripheral surface of a wire or a rod constituting the support member to enable the swinging motion and thus a balancing of moments.

The concave saddle surface can preferably be configured as a gothic profile as already mentioned above.

The invention will be described more closely below with reference to one example of embodiment illustrated in a total of four figures.

Brief description of the drawings

- Fig. 1 shows a cross-section of a linear guide unit of the invention,
- Fig. 2 shows an enlarged detail of the linear guide unit of Fig. 1,
- Fig. 3 is an enlarged representation of the saddle member of the linear guide unit of Fig. 1, and
- Fig. 4 is a schematic representation of a longitudinal section through the linear guide unit of the invention.

Detailed description of the drawings

The linear guide unit of the invention illustrated in Figs. 1 to 4 comprises a guide carriage 3 that is mounted through balls 2 for sliding on a guide rail 1. The guide carriage 3 comprises a carrier body 4 and, as shown only schematically in Fig. 4, end caps 5 fixed on front ends of the carrier body 4. The linear guide unit comprises a total of four endless rolling element channels 6 for the balls 2, as likewise only schematically shown in Figs. 4 and 1. Each rolling element channel 6 comprises a load-bearing channel 7 for load-bearing rolling elements, a return channel 8 for returning balls 2 and two deflecting channels 9 that connect the load-bearing channel 7 and the return channel 8 endlessly to each other and are defined by the end caps 5.

A support rail 10 is arranged on each side of the guide rail 1 along the load-bearing channel 7. The support rail 10 comprises a support member 11 and a saddle member 12. The support member 11 has a circular cross-section and is configured in the form of a wire. This wire is received in a groove 13 of the carrier body 4. As seen in cross-section, the groove 13 has a gothic profile 15, as shown in Fig. 2. This gothic profile 15 may also be called a pointed arch profile, but the arch may be only so slightly pointed that it resembles a circular arch profile. The groove wall surrounds more than half the circumference of the wire, so that the wire constituting the support member 11 is received secure against loss in the groove 13.

With two parallel raceways 16, the saddle member 12 defines respective load-bearing channels 7. The balls 2 are in rolling contact under load with the raceways 16 which are configured as ball grooves and preferably likewise have a gothic profile.

On its side facing the support member 11, the saddle member 12 comprises a concave saddle surface 17 that preferably likewise has a gothic profile. The saddle member 12 is supported through its saddle surface 17 on the support member 11, it being assured that the saddle member 12 can tilt about the longitudinal axis of the support member 11 so that any occurring moments and thus also bracing can be avoided through compensating movements.

A first coefficient of friction is chosen between the carrier body 4 and the support member 11, and a second coefficient of friction is chosen between the support member 11 and the saddle member 12, the first coefficient of friction being set to be larger than the second coefficient of friction. In this way, it is assured that relative displacements are possible between the saddle member 12 and the support member 11 but not between the support member 11 and the carrier body 4. As a continuous cast profile, the carrier body 4 can have a soft configuration, the support member 11 and the saddle member 12, in contrast, can be made of

steel hardened by heat treatment. Undesired wear of the material of the carrier body 4 is precluded in this linear guide unit of the invention.

The support member 11 cooperates through its curved convex support surface 18 with the curved concave saddle surface 17 of the saddle member 12. Relative movements take place between these two surfaces to enable the aforesaid compensating movements. In the present embodiment, the support surface 18 is formed in a particularly simple manner by the cylindrical outer peripheral surface of the wire.

The carrier body 4 made by continuous casting is finished by vibratory grinding so that undesired sharp edges are broken.

The approximately triangular saddle member 12 comprises one of the raceways 16 on each of its first and second side. On its third side, the saddle member 12 comprises the saddle surface 17 that is arranged at the center between the two raceways 16. This symmetric arrangement guarantees, on the one hand, a perfect rolling behavior and balance of moments during operation of the linear guide unit of the invention and, on the other hand, the two saddle members can be mounted irrespective of the sides, i.e. on the left and the right leg of the carrier body 4.